MANUFACTURE OF NITRIDE SEMICONDUCTOR LASER ELEMENT

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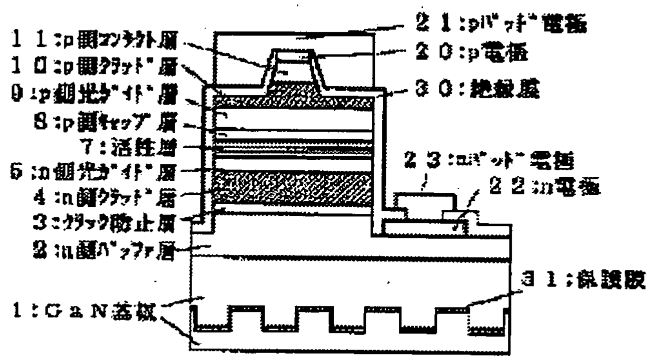
Abstract of **JP2000082867**

PROBLEM TO BE SOLVED: To enable a nitride semiconductor laser element to have a resonance surface nearly equal to a mirror surface by a method wherein the nitride semiconductor element is cleaved making a certain plane of a gallium nitride serve as a cleaving plane to have a resonance lane like a mirror surface when the nitride semiconductor element formed on a gallium nitride substrate isolated from a sapphire substrate is cleaved. SOLUTION: A nitride semiconductor is laminated on a GaN substrate 1, a ridge is provided in the nitride semiconductor so as to be parallel with the M plane of the GaN substrate 1 by etching a P-side contact layer 11 and a P-side clad layer 10, the ridge is masked, and etching is carried out in parallel with the ridge so as to make the surface of an N-side buffer layer 2 exposed. A p-electrode 20 is formed on the surface of the ridge, an N electrode 22 is formed on the exposed surface of the N-side buffer layer 2, lastly a P pad electrode 21 is formed on the P electrode 20 through the intermediary of an insulating film 30, and an N pad electrode 23 is formed on the N electrode 22 through, the intermediary of the insulating film 30, whereby a wafer can be obtained. The wafer is cleaved at a plane A to make it serve as a resonance plane, a multilayered dielectric film composed of SiO_2 and TiO_2 is formed on both or either of the resonance planes, and a bar is cut in parallel with the ridge into laser chips.



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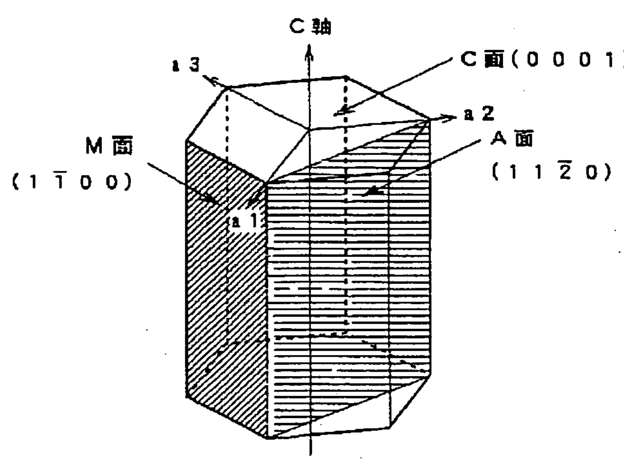
(54)【発明の名称】　窒化物半導体レーザ素子の製造方法

(57)【要約】
【目的】　劈開により活性層の端面に共振面が形成された窒化物半導体レーザ素子の製造方法を提供する。
【構成】　窒化物半導体レーザのリッジを形成する際、そのリッジを窒化物半導体のＭ面と平行に形成し、このリッジに対して垂直にＡ面で劈開することにより共振面を形成する。



Ａ面　(11$\bar{2}$0) (2$\bar{1}\bar{1}$0) (1$\bar{2}$10) ($\bar{1}$120) ($\bar{2}$110) ($\bar{1}$2$\bar{1}$0)
Ｍ面　(1$\bar{1}$00) (0$\bar{1}$10) ($\bar{1}$010) ($\bar{1}$100) (01$\bar{1}$0) (10$\bar{1}$0)

【特許請求の範囲】

【請求項１】窒化物半導体よりなる基板上にレーザ素子の構造を積層した後、その基板を

【外１】

$$(1\,1\,\bar{2}\,0)$$

【外２】

$$(2\,\bar{1}\,\bar{1}\,0)$$

【外３】

$$(1\,\bar{2}\,1\,0)$$

【外４】

$$(\bar{1}\,\bar{1}\,2\,0)$$

【外５】

$$(\bar{2}\,1\,1\,0)$$

【外６】

$$(\bar{1}\,2\,\bar{1}\,0)$$

面内のいずれかの面方位で割ることにより半導体レーザ素子の光共振面を作製することを特徴とする窒化物半導体レーザ素子の製造方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、例えばＬＥＤ（発光ダイオード）、ＬＤ（レーザダイオード）等の窒化物半導体（$In_XAl_YGa_{1-X-Y}N$、０≦Ｘ、０≦Ｙ、Ｘ＋Ｙ≦１）よりなる素子の製造方法に関する。

【０００２】

【従来の技術】近年、窒化物半導体からなる青色、青緑色の発光ダイオード、レーザダイオードが実用化されたり、実用可能になっている。このような窒化物半導体素子は、現在のところ窒化物半導体と完全に格子整合する基板が未だ開発されていないため、格子定数が異なるサファイアの上に窒化物半導体を強制的に成長させて形成されている。そのためサファイア基板上に成長された窒化物半導体の結晶には、格子整合した基板上に成長された赤色レーザ素子と比べると、非常に多くの結晶欠陥が発生する。

【０００３】本発明者等は、結晶欠陥を大幅に低減できる窒化物半導体の結晶成長方法として、窒化物半導体と異なる異種基板上に窒化ガリウム基板を形成し、その窒化ガリウム基板上に素子構造を形成することにより、波長約４００ｎｍ、光出力２ｎＷで連続発振約１万時間を達成できる窒化物半導体レーザー素子などを開示している（例えば「ＩｎＧａＮ系多重量子井戸構造半導体レーザの現状」、第５８回応用物理学会学術講演会、講演番号４ａＺＣ－２，１９９７年10月、”Ｐｒｅｓｅｎｔ Ｓｔａｔｕｓ ｏｆ ＩｎＧａＮ／ＡｌＧａＮ ｂａｓｅｄ Ｌａｓｅｒ Ｄｉｏｄｅｓ”、Ｔｈｅ Ｓｅｃｏｎｄ ＩｎｔｅｒｎａｔｉｏｎａｌＣｏｎｆｅｒｅｎｃｅ ｏｎ Ｎｉｔｒｉｄｅ Ｓｅｍｉｃｏｎｄｕｃｔｏｒｓ（ＩＣＮＳ’９７）、講演番号Ｓ－１、１９９７年１０月などに記載されている。）。

【０００４】上記の結晶成長方法は、サファイア基板上に従来の結晶欠陥が非常に多い窒化ガリウム層を薄く成長させ、その上にSiO_2よりなる保護膜を部分的に形成し、その保護膜の上からハライド気相成長法（ＨＶＰＥ）、有機金属気相成長法（ＭＯＶＰＥ）等の気相成長法により、窒化ガリウムの横方向への成長を利用し、再度窒化ガリウム層を成長させることにより、結晶欠陥の少ない窒化ガリウム基板（膜厚１０μｍ）を形成する技術である。この方法は窒化物半導体を保護膜上で横方向に成長させることから、一般にラテラルオーバーグロウス（ｌａｔｅｒａｌ ｏｖｅｒ ｇｒｏｗｔｈ：ＬＯＧ）と呼ばれている。

【０００５】上記技術において、結晶欠陥が少なくなった窒化ガリウム基板を用いることにより素子の性能の向上が見られたものの、上記窒化物半導体素子の基板とされるサファイアは、非常に硬く劈開性がないために、ウエハーをチップ化するのに高度な技術を必要とする。更に、サファイアには劈開性がほとんどないために、レーザ素子の形成において基板の劈開性を用いて窒化物半導体の劈開面を共振面としにくく、共振面の形成に時間と手間がかかる。

【０００６】

【発明が解決しようとする課題】そこで、サファイア基板を研磨により除去することで、窒化ガリウム基板のみを得て、この基板上に素子となる構造を積層していた。この窒化ガリウム基板上の窒化物半導体素子を劈開する際、今までは、窒化ガリウムのＭ面を劈開面として、劈開していた。Ｍ面とは窒化物半導体を六角柱状の六方晶系で近似した場合に、その劈開面に相当する四角形の面であり、

【０００７】

【外７】

$$(1\,\bar{1}\,0\,0)$$

【０００８】（以下、Ｍ面と記載する。）面などの６種類の面方位で示すことができる。窒化物半導体のＭ面で劈開すると、非常に歩留良く、また鏡面に近い共振面を含む劈開面を得ることができる。

【０００９】

【課題を解決するための手段】本発明はサファイア基板から分離した窒化ガリウム基板上の窒化物半導体素子を劈開する際、窒化ガリウムの面

【００１０】

【外８】

$$(1\,1\,\bar{2}\,0)$$

【００１１】

【外９】

$$(2\,\bar{1}\,\bar{1}\,0)$$

【００１２】

【外１０】

$$(1\,\bar{2}\,1\,0)$$

【0013】
【外11】

$$(\bar{1}\bar{1}20)$$

【0014】
【外12】

$$(\bar{2}110)$$

【0015】
【外13】

$$(\bar{1}2\bar{1}0)$$

【0016】（以下（外8）乃至（外13）面は同一A面を示すので、A面とまとめて記載する。）を劈開面として劈開し、鏡面に近い共振面を得ることを特徴とする。

【0017】
【発明の実施の形態】更に図を用いて説明する。図1は窒化物半導体の結晶構造を模式的に示すユニットセル図である。窒化物半導体は正確には菱面体構造であるが、このように六方晶系で近似できる。ＧａＮにおいては劈開面としてＭ面とＡ面とがある。この劈開面を使って窒化物半導体が積層されたウエハーをチップ化すれば、鏡面に近い共振面を得ることができる。

【0018】図２及び図３は、窒化ガリウム基板上に積層した窒化物半導体レーザの共振方向に垂直な面で切断したときの図である。図２はｐ電極とｎ電極が同一面上に、図３は別の面上に形成されている。この切断面を窒化物半導体のＡ面の劈開性を用いて形成する。その方法は、ｐ側層表面をエッチングしてリッジを形成する際に窒化物半導体のＭ面と平行（Ａ面と垂直）になるようにリッジを形成し、このリッジに対して垂直に劈開をする。それがすなわちＡ面の劈開性を用いて共振面を形成したことになる。

【0019】
【実施例】以下に本発明の実施例を示すが本発明はこれに限定されない。

［実施例１］図２はレーザ光の共振方向に垂直な方向で素子を切断した際の図を示している。以下、この図を元に実施例１について説明する。

【0020】まずＧａＮ基板１を得る。異種基板として、サファイア基板をＭＯＶＰＥ反応容器内にセットし、ＧａＮよりなるバッファ層を２００オングストローム、アンドープＧａＮよりなる下地層を４μｍ（下地層とは次の窒化物半導体基板を選択成長させるための層）、ＣＶＤ装置によりSiO_2よりなる第１の保護膜をストライプ状（ストライプ幅１０μｍ、ストライプ間隔（窓部）２μｍ）に１μｍ、ＭＯＶＰＥ法でアンドープＧａＮよりなる窒化物半導体基板を１０μｍ、ＨＶＰＥ法でアンドープＧａＮよりなるＧａＮ基板を２００μｍ、それぞれの膜厚で積層する。

【0021】次に図２に示すように積層したＧａＮにエッチングによりストライプ状の段差を設ける。この段差の上面すべてにSiO_2等の第２の保護膜３１を形成して、続いてＧａＮを積層する際のＧａＮの上面への縦方向の成長を抑え、ＧａＮは第２の保護膜３１で覆われていない部位からの横方向の成長を始める。ＧａＮの縦方向の成長を抑え、横方向のみに成長させ、続いて縦と横方向に成長させることで、結晶欠陥の極めて少ない、結晶性の良好なＧａＮ基板１を得ることができる。

【0022】続いてウエハーを、サファイア基板側から第１の保護膜までを研磨していき、ＧａＮ基板１のみを得る。次にＧａＮ基板上に窒化物半導体をｎ側バッファ層、クラック防止層、ｎ側クラッド層、ｎ側光ガイド層、活性層、ｐ側キャップ層、ｐ側光ガイド層、ｐ側クラッド層、ｐ側コンタクト層の順で積層した。

【0023】以上のようにしてＧａＮ基板上に積層した窒化物半導体に、ｐ側コンタクト層とｐ側クラッド層をエッチングして、ＧａＮのＭ面と平行（Ａ面と垂直）になるようにリッジを形成し、リッジをマスク後、リッジと平行にエッチングしてｎ側バッファ層の表面を露出させる。また、形成したリッジ表面にｐ電極を、露出させたｎ側バッファ層上にｎ電極を形成し、最後にｐ電極とｎ電極との間に絶縁膜を介し、ｐ電極上にｐパッド電極、ｎ電極上にｎパッド電極を形成して、ウエハーを完成させる。

【0024】このウエハーをチップ化する際、まずＡ面で劈開（リッジと垂直に劈開）することで、共振面を作製する。共振面の両方あるいはどちらか一方にSiO_2とTiO_2よりなる誘電体多層膜を形成し、最後にリッジと平行な方向で、バーを切断してレーザチップとした。このレーザ素子は室温でレーザ発振を示し、閾値電流密度１．５ｋＡ／cm^2において室温連続発振を示し、２０ｍＷの出力において１０００時間以上の寿命を示し、Ｍ面で共振面を形成したときと同等の結果が得られた。

［実施例２］図３は本発明の他の実施例に係るレーザ素子の構造を示す模式的な断面図であり、図２と同じくレーザ光の共振方向に垂直な方向で素子を切断した際の図を示している。以下この図を元に実施例２について説明する。

【0025】まず異種基板として、サファイア基板をＭＯＶＰＥ反応容器内にセットし、ＧａＮよりなるバッファ層を２００オングストローム、アンドープＧａＮよりなる下地層を４μｍ、ＣＶＤ装置によりSiO_2よりなる第１の保護膜をストライプ状（ストライプ幅１０μｍ、ストライプ間隔（窓部）２μｍ）に１μｍ、ＭＯＶＰＥ法でＳｉドープＧａＮよりなる窒化物半導体基板を１０μｍ、ＨＶＰＥ法でＳｉドープＧａＮよりなるＧａＮ基板を２００μｍ、それぞれの膜厚で積層し、続いてウエハーを、サファイア基板側から第１の保護膜までを研磨していき、ＧａＮ基板１のみを得る。

【0026】第１の保護膜を除去した後のＧａＮ基板１

の表面を第1の主面と第2の主面とし、第1の主面上に、n側光ガイド層と活性層の間にn側キャップ層を成長させる以外は実施例1と同様にして、n側バッファ層、クラック防止層、n側クラッド層、n側光ガイド層、n側キャップ層、活性層、p側キャップ層、p側光ガイド層、p側クラッド層、p側コンタクト層の順で積層する。

【0027】GaNのM面と平行(A面と垂直)になるようにリッジを形成後、リッジ最表面に絶縁膜、p電極およびpパッド電極を形成した。p側電極形成後、第2の主面上にn電極およびボンディング用電極を形成する。このウエハーをチップ化する際、実施例1と同様にして、まずA面で劈開(リッジと垂直に劈開)することで、共振面を作製する。共振面の両方あるいはどちらか一方にSiO_2とTiO_2よりなる誘電体多層膜を形成し、最後にp電極に平行な方向で、バーを切断してレーザチップとした。

【0028】このレーザ素子も実施例1と同様に室温で連続発振を示し、閾値電流密度1.5kA/cm^{2}において室温連続発振を示し、20mWの出力において1000時間以上の寿命を示し、M面で共振面を形成したときと同等の結果が得られた。

【0029】

【発明の効果】以上示したように本発明はサファイア基板から分離した窒化ガリウム基板上の窒化物半導体素子を劈開する際、新たに窒化ガリウムのA面を劈開面として劈開することで、鏡面に近い共振面を持つ窒化物半導体レーザが実現可能となった。なお、本発明では窒化ガリウム基板について説明したが、サファイア基板やスピネル基板上に積層し、窒化物半導体を積層した後、そのサファイア基板やスピネル基板を薄く研磨した場合についても適用可能である。

【図面の簡単な説明】

【図1】窒化物半導体の結晶構造を模式的に示すユニットセル図である。

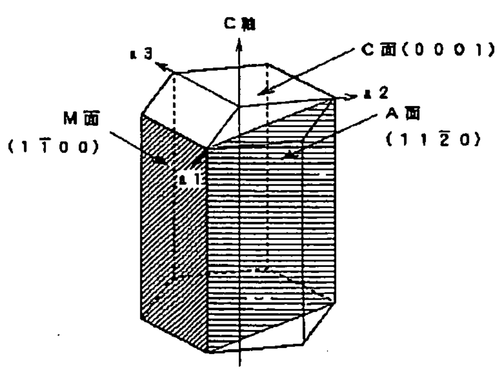
【図2】本発明の一実施例に係るレーザ素子の構造を示す概略断面図である。

【図3】本発明の一実施例に係るレーザ素子の構造を示す概略断面図である。

【符号の簡単な説明】

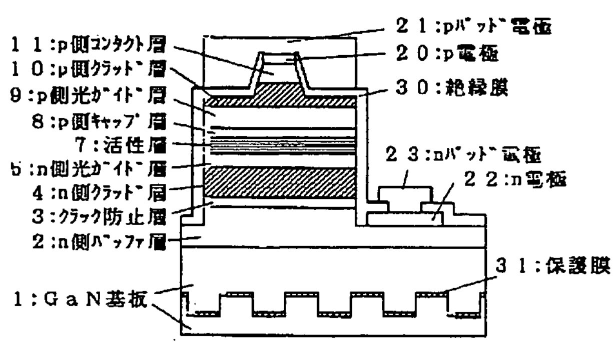
1・・・GaN基板
2・・・n側バッファ層
3・・・クラック防止層
4・・・n側クラッド層
5・・・n側光ガイド層
6・・・n側キャップ層
7・・・活性層
8・・・p側キャップ層
9・・・p側光ガイド層
10・・・p側コンタクト層
20・・・p電極
21・・・pパッド電極
22・・・n電極
30・・・絶縁膜
31・・・第2の保護膜

【図1】

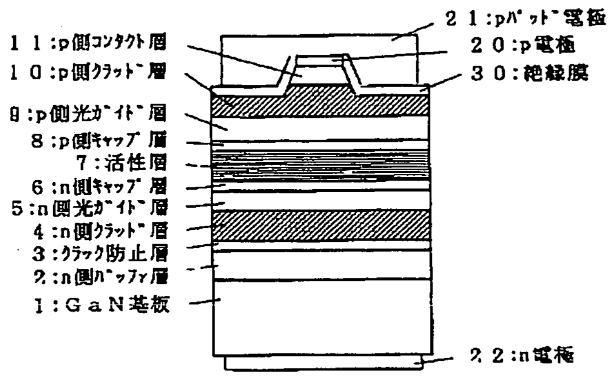


A面 (11$\bar{2}$0) (2$\bar{1}\bar{1}$0) (1$\bar{2}$10) ($\bar{1}\bar{1}$20) ($\bar{2}$110) ($\bar{1}$2$\bar{1}$0)
M面 (1$\bar{1}$00) (0$\bar{1}$10) ($\bar{1}$010) ($\bar{1}$100) (01$\bar{1}$0) (10$\bar{1}$0)

【図2】



【図3】


21:pパッド電極
20:p電極
30:絶縁膜
11:p側コンタクト層
10:p側クラッド層
9:p側光ガイド層
8:p側キャップ層
7:活性層
6:n側キャップ層
5:n側光ガイド層
4:n側クラッド層
3:クラック防止層
2:n側バッファ層
1:GaN基板
22:n電極

PATENT ABSTRACTS OF JAPAN

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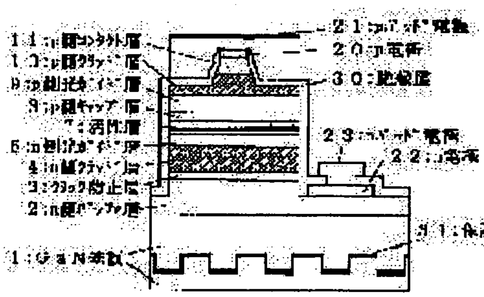
(54) MANUFACTURE OF NITRIDE SEMICONDUCTOR LASER ELEMENT



(57)Abstract:

PROBLEM TO BE SOLVED: To enable a nitride semiconductor laser element to have a resonance surface nearly equal to a mirror surface by a method wherein the nitride semiconductor element is cleaved making a certain plane of a gallium nitride serve as a cleaving plane to have a resonance lane like a mirror surface when the nitride semiconductor element formed on a gallium nitride substrate isolated from a sapphire substrate is cleaved.

SOLUTION: A nitride semiconductor is laminated on a GaN substrate 1, a ridge is provided in the nitride semiconductor so as to be parallel with the M plane of the GaN substrate 1 by etching a P-side contact layer 11 and a P-side clad layer 10, the ridge is masked, and etching is carried out in parallel with the ridge so as to make the surface of an N-side buffer layer 2 exposed. A p-electrode 20 is formed on the surface of the ridge, an N electrode 22 is formed on the exposed surface of the N-side buffer layer 2, lastly a P pad electrode 21 is formed on the P electrode 20 through the intermediary of an insulating film 30, and an N pad electrode 23 is formed on the N electrode 22 through, the intermediary of the insulating film 30, whereby a wafer can be obtained. The wafer is cleaved at a plane A to make it serve as a resonance plane, a multilayered dielectric film composed of SiO2 and TiO2 is formed on both or either of the resonance planes, and a bar is cut in parallel with the ridge into laser chips.

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[Claim(s)]
[Claim 1] It is [External Character 1] about the substrate after carrying out the laminating of the structure of a laser component on the substrate which consists of a nitride semi-conductor.

$(1\ 1\ \bar{2}\ 0)$

$(2\ \bar{1}\ \bar{1}\ 0)$

$(1\ \bar{2}\ 1\ 0)$

$(\bar{1}\ \bar{1}\ 2\ 0)$

$(\bar{2}\ 1\ 1\ 0)$

$(\bar{1}\ 2\ \bar{1}\ 0)$

The manufacture approach of the nitride semiconductor laser component characterized by producing the optical resonance side of a semiconductor laser component by breaking by field bearing of either of the fields.
[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the manufacture approach of the component which consists of nitride semi-conductors (InXAlYGa1-X-YN, 0 <=X, 0<=Y, X+Y<=1), such as LED (light emitting diode) and LD (laser diode).
[0002]
[Description of the Prior Art] The light emitting diode of the blue which consists of a nitride semi-conductor, and a bluish green color, and a laser diode are put in practical use in recent years, or practical use has become possible. Since the substrate which now carries out lattice matching to a nitride semi-conductor thoroughly is not yet developed, on the sapphire with which lattice constants differ, such a nitride semiconductor device grows up a nitride semi-conductor compulsorily, and is formed. Therefore, into the crystal of the nitride semi-conductor which grew on silicon on sapphire, very many crystal defects occur compared with the red laser component which grew on the substrate which carried out lattice matching.

[0003] By this invention person's etc. forming a gallium nitride substrate on a different different-species substrate from a nitride semi-conductor as the crystal growth approach of a nitride semi-conductor that a crystal defect can be reduced substantially, and forming component structure on the gallium nitride substrate the wavelength of about 400nm, the nitride semiconductor laser component which can attain continuous-oscillation about 10,000 hours by optical output 2nW are indicated (for example, "the actual condition of InGaN system multiplex quantum well structure semiconductor laser" --) The 58th Japan Society of Applied Physics scientific lecture meeting, lecture number 4aZC-October, 1997 [2 or], "Present Status of InGaN/AlGaN based Laser Diodes", The Second InternationalConference on Nitride It is indicated in Semiconductors (ICNS'97), lecture number S-October, 1997 [1 or], etc. .
[0004] The above-mentioned crystal growth approach is a technique which forms [by growing up thinly a gallium nitride layer with very many conventional crystal defects on silicon on sapphire, and forming selectively the protective coat which consists of SiO2 on it] a gallium nitride substrate with few crystal defects (10 micrometers of thickness) by using growth in the longitudinal direction of gallium nitride, and growing up a gallium nitride layer again by vapor growth, such as halide vapor growth (HVPE) from the protective coat, and metal-organic chemical vapor deposition (MOVPE). Generally from growing up a nitride semi-conductor into a longitudinal direction on a protective coat, this approach is called lateral overgrowth (lateral over growth:LOG).
[0005] In the above-mentioned technique, although improvement in the engine performance of a component was found by using the gallium nitride substrate whose crystal defect decreased, since there is no cleavability very firmly, the sapphire used as the substrate of the above-mentioned nitride semiconductor device needs an advanced technique for chip-izing a wafer. Furthermore, since there is almost no cleavability in sapphire, in formation of a laser component, it is hard to make the cleavage plane of a nitride semi-conductor into a resonance side using the cleavability of a substrate, and formation of a resonance side takes time amount and time and effort.
[0006]
[Problem(s) to be Solved by the Invention] Then, by removing silicon on sapphire by polish, only the gallium nitride substrate was obtained and the laminating of the structure which serves as a component on this substrate was carried out. When carrying out cleavage of the nitride semiconductor device on this gallium nitride substrate, it was carrying out cleavage until now, having used the Mth page of gallium nitride as the cleavage plane. In the Mth page, it is the field of the square which is equivalent to the cleavage plane when a nitride semi-conductor is approximated with hexagonal prism-like hexagonal system, and is [0007].
$(1\,\bar{1}\,0\,0)$

[0008] (It is hereafter indicated as the Mth page.) Six kinds of field bearings, such as a field, can show. If cleavage is carried out by the Mth page of a nitride semi-conductor, the cleavage plane which includes the resonance side near a mirror plane with a very sufficient yield can be obtained.
[0009]
[Means for Solving the Problem] This invention is the field [0010] of gallium nitride, in case cleavage of the nitride semiconductor device on the gallium nitride substrate separated from silicon on sapphire is carried out.
$(1\,1\,\bar{2}\,0)$

[0011]
$(2\,\bar{1}\,\bar{1}\,0)$

[0012]
$(1\,\bar{2}\,1\,0)$

[0013]
$(\bar{1}\,\bar{1}\,2\,0)$

[0014]
$(\bar{2}\,1\,1\,0)$

[0015]
$(\bar{1}\,2\,\bar{1}\,0)$

[0016] (-- the following (outside 8) thru/or (outside 13) a field are the same -- since the Ath page is shown, it collects with the Ath page and indicates.) -- it considers as a cleavage plane, and cleavage is carried out and it is characterized by acquiring the resonance side near a mirror plane.
[0017]
[Embodiment of the Invention] Furthermore, it explains using drawing. Drawing 1 is unit cell drawing showing the crystal structure of a nitride semi-conductor typically. Although a nitride semi-conductor is rhombohedron structure, it can be approximated to accuracy with hexagonal system in this way. In GaN, there are the Mth page and the Ath page as a cleavage plane. If a nitride semi-conductor chip-izes the wafer by which the laminating was carried out using this cleavage plane, the resonance side near a mirror plane can be acquired.
[0018] Drawing 2 and drawing 3 are drawings when cutting in respect of being vertical to the resonance direction of the nitride semiconductor laser which carried out the laminating on the gallium nitride substrate. As for drawing 2 , p electrode and n electrode are formed on the same side on field where drawing 3 is another. This cutting plane is formed using the cleavability of the Ath page of a nitride semi-conductor. In case that approach etches the p side layer front face and forms a ridge, it forms a ridge so that it may become the Mth page and parallel (vertical to the Ath page) of a nitride semi-conductor, and it carries out cleavage vertically to this ridge. It means forming a resonance side using the cleavability of that, i.e., the Ath page.
[0019]
[Example] Although the example of this invention is shown below, this invention is not limited to this.
[Example 1] drawing 2 shows drawing at the time of cutting a component in a direction vertical to the resonance direction of a laser beam. Hereafter, an example 1 is explained based on this drawing.
[0020] The GaN substrate 1 is obtained first. As a different-species substrate, silicon on sapphire is set in a MOVPE reaction container. The substrate layer which consists of 200A and undoping GaN the buffer layer which consists of GaN 4 micrometers (layer for carrying out selective growth of the following nitride semi-conductor substrate to a substrate layer), It is the shape of a stripe (stripe width of face of 10 micrometers) about the 1st protective coat which consists of SiO2 with a CVD system. stripe spacing (window part) of 2 micrometers -- 1 micrometer and MOVPE -- the nitride semi-conductor substrate which consists of undoping GaN by law -- 10 micrometers and HVPE -- the laminating of the GaN substrate which consists of undoping GaN by law is carried out by 200 micrometers and each thickness.
[0021] Next, a stripe-like level difference is prepared in GaN which carried out the laminating as shown in drawing 2 by etching. Forming the 2nd protective coat 31 of SiO2 grade in all the top faces of this level difference, growth of the lengthwise direction to the top face of GaN at the time of carrying out the laminating of the GaN continuously is suppressed, and GaN begins growth of the longitudinal direction from the part which is not covered by the 2nd protective coat 31. Very little crystalline good GaN substrate 1 of a crystal defect can be obtained by suppressing growth of the lengthwise direction of GaN, making it grow up to be only a longitudinal direction, and making it grow up to be length and a longitudinal direction continuously.

[0022] Then, the wafer is ground for from a silicon-on-sapphire side to the 1st protective coat, and only the GaN substrate 1 is obtained. Next, the laminating of the nitride semi-conductor was carried out on the GaN substrate in the order of the n side buffer layer, a crack prevention layer, the n side cladding layer, the n side lightguide layer, a barrier layer, the p side cap layer, the p side lightguide layer, the p side cladding layer, and the p side contact layer.
[0023] the p side contact layer and the p side cladding layer are etched, a ridge is formed so that it may become M side of GaN, and parallel (vertical to the Ath page), a ridge is etched into after a mask, a ridge, and parallel, and the front face of the n side buffer layer is exposed to the nitride semi-conductor which carried out the laminating on the GaN substrate as mentioned above. Moreover, n electrode is formed on the n side buffer layer which exposed p electrode on the formed ridge front face, finally n pad electrode is formed on p electrode through an insulator layer at p pad electrode and n electrode top between p electrode and n electrode, and a wafer is completed.
[0024] In case this wafer is chip-ized, a resonance side is produced by carrying out cleavage (it being cleavage at right angles to a ridge) by the Ath page first. The dielectric multilayer which becomes both resonance sides or either from SiO2 and TiO2 was formed, and finally, it is a direction parallel to a ridge, and the bar was cut and it considered as the laser chip. This laser component showed laser oscillation at the room temperature, room temperature continuous oscillation was shown in threshold-current consistency 1.5 kA/cm2, the life of 1000 hours or more was shown in the output of 20mW, and the result equivalent to the time of forming a resonance side by the Mth page was obtained.
[Example 2] drawing 3 is the typical sectional view showing the structure of the laser component concerning other examples of this invention, and shows drawing at the time of cutting a component in the direction [same with drawing 2] vertical to the resonance direction of a laser beam. An example 2 is explained below based on this drawing.
[0025] Silicon on sapphire is first set in a MOVPE reaction container as a different-species substrate. The substrate layer which consists of 200A and undoping GaN the buffer layer which consists of GaN 4 micrometers, It is the shape of a stripe (stripe width of face of 10 micrometers) about the 1st protective coat which consists of SiO2 with a CVD system. stripe spacing (window part) of 2 micrometers -- 1 micrometer and MOVPE -- the nitride semi-conductor substrate which consists of an Si dope GaN by law 10 micrometers The wafer is continuously carried out the laminating of the GaN substrate which consists of an Si dope GaN by 200 micrometers and each thickness and ground for from a silicon-on-sapphire side to the 1st protective coat by the HVPE method, and only the GaN substrate 1 is obtained.
[0026] Make the front face of the GaN substrate 1 after removing the 1st protective coat into the 1st principal plane and 2nd principal plane, and it is made to be the same as that of an example 1 except growing up the n side cap layer between the n side lightguide layer and a barrier layer on the 1st principal plane. A laminating is carried out in the order of the n side buffer layer, a crack prevention layer, the n side cladding layer, the n side lightguide layer, the n side cap layer, a barrier layer, the p side cap layer, the p side lightguide layer, the p side cladding layer, and the p side contact layer.
[0027] The insulator layer, p electrode, and p pad electrode were formed in the ridge outermost surface after forming a ridge so that it might become the Mth page and parallel (vertical to the Ath page) of GaN. n electrode and the electrode for bondings are formed on the 2nd principal plane after p lateral electrode formation. In case this wafer is chip-ized, a resonance side is produced like an example 1 by carrying out cleavage (it being cleavage at right angles to a ridge) by the Ath page first. The dielectric multilayer which becomes both resonance sides or either from SiO2 and TiO2 was formed, and finally, it is a direction parallel to p electrode, and the bar was cut and it considered as the laser chip.
[0028] The room temperature showed continuous oscillation like [this laser component] the example 1, room temperature continuous oscillation was shown in threshold-current consistency 1.5 kA/cm2, the life of 1000 hours or more was shown in the output of 20mW, and the result equivalent to the time of forming a resonance side by the Mth page was

obtained.

[0029]

[Effect of the Invention] As shown above, when this invention carried out cleavage of the nitride semiconductor device on the gallium nitride substrate separated from silicon on sapphire, it is that it newly carries out cleavage, using the Ath page of gallium nitride as a cleavage plane, and nitride semiconductor laser with the resonance side near a mirror plane became realizable. In addition, although this invention explained the gallium nitride substrate, after carrying out a laminating on silicon on sapphire or a spinel substrate and carrying out the laminating of the nitride semi-conductor, it is applicable also about the case where the silicon on sapphire and spinel substrate are ground thinly.

[Brief Description of the Drawings]

[Drawing 1] It is unit cell drawing showing the crystal structure of a nitride semi-conductor typically.

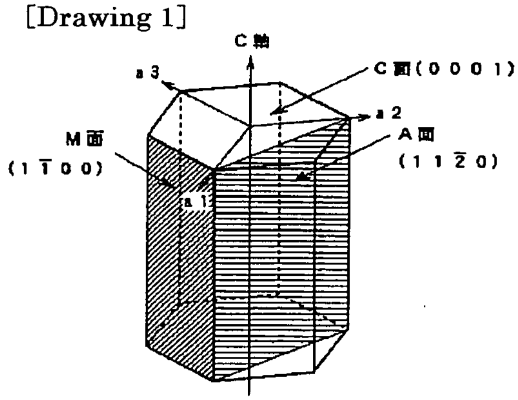
[Drawing 2] It is the outline sectional view showing the structure of the laser component concerning one example of this invention.

[Drawing 3] It is the outline sectional view showing the structure of the laser component concerning one example of this invention.

[Brief Description of Notations]

1 ... GaN substrate
2 ... The n side buffer layer
3 ... Crack prevention layer
4 ... The n side cladding layer
5 ... The n side lightguide layer
6 ... The n side cap layer
7 ... Barrier layer
8 ... The p side cap layer
9 ... The p side lightguide layer
10 ... The p side contact layer
20 ... p electrode
21 ... p pad electrode
22 ... n electrode
30 ... Insulator layer
31 ... The 2nd protective coat

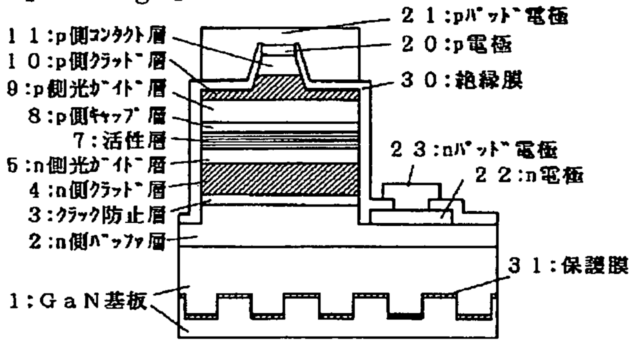
[Drawing 1]



A面 (11$\bar{2}$0) (2$\bar{1}\bar{1}$0) (1$\bar{2}$10) ($\bar{1}\bar{1}$20) ($\bar{2}$110) ($\bar{1}$2$\bar{1}$0)

M面 (1$\bar{1}$00) (0$\bar{1}$10) ($\bar{1}$010) ($\bar{1}$100) (01$\bar{1}$0) (10$\bar{1}$0)

[Drawing 2]



[Drawing 3]